

GEOLOGICA MACEDONICA



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| <i>Geologica Macedonica</i> | Год. | 22 | стр. | 1-62 | Штип | 2008 |
| <i>Geologica Macedonica</i> | Vol. | | pp. | | [tip | |

CORRELATION OF STRATIGRAPHIC DISTRIBUTION OF THE FORAMINIFERS IN THE OVČE POLE AND TIKVEŠ PALEOGENE BASIN, THE REPUBLIC OF MACEDONIA

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A b s t r a c t: The Ovče Pole and Tikveš Paleogene basins are big sedimentary complexes, which belong to the eastern and central part of the Vardar zone within the territory of the Republic of Macedonia.

In accordance to previous studies, the age of the Paleogene sediments (based on numerous fossils from the microfossil groups) in the Ovče Pole and Tikveš basins has been determined as Upper Eocene.

The results of the micropaleontological investigations on the plankton of foraminifer fauna, found in the upper flysch lithozones of the OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin) drill holes. The biostratigraphical value of the plankton of foraminifer fauna in drillings OP-1 and KR-1 gave us the chance to divide one local biostratigraphical zone in the Ovče Pole and Tikveš basin.

In relation to this, correlation of the biostratigraphical zones was made between the Ovče Pole and Tikveš Paleogene basin.

Key words: Paleogene; benthic and planktonic foraminifers; biostratigraphic zone; Ovče Pole basin; Tikveš basin

INTRODUCTION

The paleogene sediments in Macedonia are widely spread on the area of the Vardar zone, where they are divided in two main basins: Tikveš and Ovče Pole, in which the sediment accumulations are from 3000 – 3500 m thick.

Tikveš basin is situated in the south-west part of the territory of Macedonia and belongs to the central part of the Vardar zone.

Ovče Pole basin is mainly distributed in the east and central Vardar subzone. To the south and south-west connects with the Tikveš basin (Fig. 1).

According to the previous explorations, the age of the paleogene sediments (based on plenty fossil remains from macrofossil groups) in the Ovče Pole and Tikveš basin is determined upper eocene.

According to the lithological characteristics, the sediment mass in the paleogene basins with 3000–3500 m thickness, is consisted from four lithostratigraphic units (lithozones): basal lithozone, lower flysch lithozones, lithozones of yellow sand-

stones and upper flysch lithozone. Lithostratigraphic composition of this basin is very similar or same, which is explored in the plenty discovered profiles and it is proven with the deep drill in the Tikveš and Ovče Pole basin.

In the period since year 1965 – 1968 on the area of the Vardar zone in the territory of Macedonia, several drills were done, previously selected with geological and geophysical studies, in order to determine the capabilities of the area, in relation with perspective of the possibilities to discover liquid and gas hydrocarbons.

The subject of this paper is the micropaleontological analyses on the plankton of foraminifer fauna in the Paleogene sediments on the OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin) drill holes. The subject of this paper is to present the results of the stratigraphic distribution of the plankton of foraminifer fauna in the Ovče Pole and Tikveš basin, which we consider as very significant for the biostratigraphic zones of the paleogene basins.

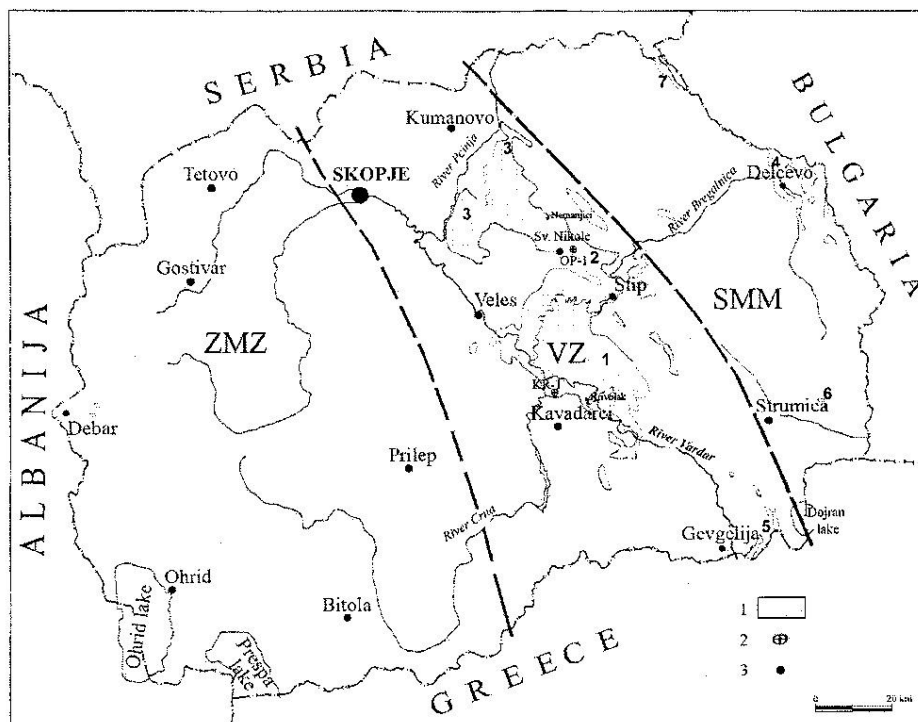


Fig. 1. Distribution of Paleogene sediments in the Republic of Macedonia
SMM – Serbian-Macedonian massif, VZ – Vardar zone, ZMZ – Western Macedonian zone,
1 – Tikveš Paleogene basin, 2 – Ovče Pole Paleogene basin, 3 – drill hole

MATERIAL AND METHODS

The study of the biostratigraphic importance of the plankton of foraminifer fauna in the studied basins is followed with stratigraphical distribution of 12 species, from 58 samples from the drill OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin), Fig. 1.

Sampling and the technical processing of foraminifer fauna from the core material of the OP-1 and KR-1 drill holes is performed using classical methods of the micropaleontological analyses (decomposition, washing, drying, selecting and determination).

RESULTS

Micropaleontological studies on foraminifer fauna of the Paleogene sediments in drill-holes OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin) have discovered rich microfossil association, which has been represented by foraminifers, ostrakodes, bryozoans, algae, radiolarii, echinodermata and micro-mollusks remainings (gastropods, lamellibranchiats). The microfauna found in the profiles OP-1 and KR-1 is tiny and degenerated, where the forms are mostly badly preserved, recrystallized and agglutinated, by which their determination is difficult.

In the sections OP-1 and KR-1 rich foraminifer fauna, represented in planktonic and benthic forms, which have the characteristic of monotony of species and bigger number of samples in the analyzed tests. The benthic foraminifers which

were found are more different, dominantly included in quantity and are represented from huge number of species and genres, and have wide vertical distribution in the Tercier and because of that they do not have particular stratigraphic importance.

The planktonic foraminifer association found in the sections OP-1 and KR-1, has allowed us to apostrophe the important stratigraphic indicators, and based on it the chronostratigraphic interpretation of the series. Biostratigraphic importance of the planktonic foraminifers represents one important criteria for separating of biozones by planktonic foraminifers is the occurrence and disappearing of particular species or group of species. Based on this standard stratigraphic zone scheme was made (Cavelier, Pomerol, 1986) for the Paleogene.

According to the standard stratigraphic scheme the Paleogene sediments in the Tikveš and Ovče Pole basin from our research are interpreted like Upper Eocene – Priabonian.

Stratigraphical data for the section OP-1

The drill OP-1 is located in the east part of the Ovče Pole basin, approximately 1.5 km. north-east from v. Ergelija (near the town of Sv. Nikole). The drilling is deep 1910 m. The drilling cuts the complex of Paleogene sediments and ends in the base represented with jura granite. Lithological members of the drilling from the bottom to the surface are represented with sediments from the basal lithozone (lake and continental red conglomerates, aleurolites, sandstone and claystone), from the lower flysch lithozone (dark gray sandstone, aleurolite and claystone) and upper flysch lithozone (marly, aleurolites, sandstone, marly oolitic limestones and clayey).

In the section of the drilling OP-1 micropaleontological sampling was performed, and 39 samples are analyzed (Fig. 2).

Benthic foraminifers found in the section OP-1 are from the genera: *Cibicides*, *Robulus*, *Eponides*, *Gyroidina*, *Pullenia*, *Planulina*, *Quinqueloculina*,

Chysalagonium, *Nonionella*, *Guttulina* and *Spiroplectammina*, which are in the sediment series in the drilling OP-1, have wide vertical distribution in the terciar, and because of that they are not with special stratigraphic importance.

Planktonic foraminifer fauna found in the sediments of the upper flysch lithozone, represented with the following representatives: *Globorotalia pseudoscutula* (Glaes), *Globigerina bulloides* d'Orbigny, *Globigerina corpulenta* Subbotina, *Globigerina eocaenica* Terquem, *Globigerina sp.*, *Globigerina venezuelana* Hedberg, *Globigerina triloculinoides* Plummer, *Globigerina eocaenica* Gumbel, *Turborotalia pomeroli* (Toumarkine & Bolli), *Globigerina officinalis* Subbotina, *Catapsydrax dissimilis* (Cushman & Bermudez), *Globigerinathea tropicalis* (Blow & Banner), *Globigerina triloculinoides* Plummer and *Globigerinathea index rubrifomis* Subbotina.

If analyses are made to the micropaleontologic section in whole, the maximal frequency and contents of plankton of foraminifera is showing in the upper flysch lithozone on deepness interval from 550 to 20 m (samples 28 – 39), i.e. in the upper parts of the section of the drill-hole, and under the depth interval from 565 m (sample 27) plankton foraminifer fauna disappears.

| Litostratigraphic unit | | | Upper flysch lithozone | | | | | | | | | | | | | Upper Eocene | | Geological age | | |
|---|--|--|------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|----------------------------|--|----------------|--|--|
| Samples | | | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 1-27 | no planktonic foraminifers | | | | |
| Depth (m) | | | 20 | 65 | 100 | 125 | 170 | 255 | 290 | 370 | 415 | 445 | 540 | 550 | 1270-565 | | | | | |
| <i>Globorotalia pseudoscutula</i> | | | | | | | | | | | | * | * | | | | | | | |
| <i>Globigerina bulloides</i> | | | * | * | * | * | | | * | * | * | | | | | | | | | |
| <i>Globigerina corpulenta</i> | | | * | | * | | | * | * | * | * | | | | | | | | | |
| <i>Catapsydrax dissimilis</i> | | | | | | * | | | * | * | | | | | | | | | | |
| <i>Globigerina venezuelana</i> | | | | | | | * | * | * | | | | | | | | | | | |
| <i>Globigerina sp.</i> | | | | | * | | * | * | | | | | | | | | | | | |
| <i>Globigerina triloculinoides</i> | | | * | | * | * | * | * | | | | | | | | | | | | |
| <i>Globigerina eocaena</i> | | | | | * | * | * | * | | | | | | | | | | | | |
| <i>Turborotalia pomeroli</i> | | | | * | * | * | * | * | | | | | | | | | | | | |
| <i>Globigerina officinalis</i> | | | | | * | | * | | | | | | | | | | | | | |
| <i>Globigerina eocaenica</i> | | | | | | * | * | | | | | | | | | | | | | |
| <i>Globigerinathea tropicalis</i> | | | * | * | * | * | | | | | | | | | | | | | | |
| <i>Globigerinathea index rubrifomis</i> | | | * | * | | | | | | | | | | | | | | | | |

Fig. 2. Distribution of planktonic foraminifers in the section OP-1

The middle part of the section, which is the bottom flysch lithozone on deepness from 782–1200 m is characterized with poor microfosil contents, which does not have stratigraphic value, and the bottom part of the profile (basal lithozone), on deepness from 1270–1798 m, is characterized with absence of microfossils.

As an index – fossils in the plankton foraminifer association, are taken the taxa: *Catapsydrax dissimilis* (Cushman & Bermudez) and *Globigerinatheka tropicalis* (Blow & Banner), which by their chronostratigraphic meaning could be classified as Upper Eocene – Priabonian, in the highest parts of the section.

Stratigraphical data for the section KR-1

The drill KR-1 is located in the valley of Kurjacka River, approximately 500 meters west from

the village of Sopot, with deepness of 2703 m (north-east from the town Kavadarci). The drilling cuts the complex of the Paleogene sediments, which is interrupted, without reaching the paleorelief. Lithological members of the drilling on the bottom to the surface are represented with sediments from the basal lithozone (clastic material, marly sandstones, clayey and sandston-aleurolites and brecciated conglomerates material) and sediments on the upper flysch lithozone (sandy-marly, marly-clays, marly and sandstones, which alternately change, with rear pro-layers conglomerates, clayey-aleurolites, and marly sandstones).

In the section KR-1 micropaleontologic sampling was made and 19 samples were analyzed (Fig. 3).

Based on the data from the micropaleontologic analyses, the foraminifer fauna from the section KR-1 (Tikveš basin) is characterized with association of benthic and planktonic foraminifers.

| Lithostratigraphic unit | Samples | Depth (m) | <i>Catapsydrax dissimilis</i> | <i>Globigerina venezuelana</i> | <i>Globigerina</i> sp. | <i>Globigerina officinalis</i> | <i>Globigerinatheka tropicalis</i> | <i>Turborotalia pomeroli</i> | <i>Globigerina triloculinoides</i> | <i>Globigerina bulloides</i> | <i>Globigerina eocaenica</i> | Geological age |
|-------------------------|---------|-----------|-------------------------------|--------------------------------|------------------------|--------------------------------|------------------------------------|------------------------------|------------------------------------|------------------------------|------------------------------|----------------|
| Upper flysch lithozone | 19 | 10–130 | | | * | * | * | * | * | * | * | Upper Eocene |
| | 18 | 150–530 | | | * | | | | | | | |
| | 17 | 540–1250 | | | * | * | | | | | | |
| | 16 | 1270–1325 | | * | * | | | | | | | |
| | 15 | 1335–1400 | | * | | | | | | | | |
| | 14 | 1410–1505 | * | | | | | | | | | |
| | 13 | 1610–1670 | * | | | | | | | | | |
| | 1–12 | 1710–2700 | no planktonic foraminifers | | | | | | | | | |

Fig. 3. Distribution of plankton of foraminifers in the section KR-1

The planktonic foraminifers association is represented with the following representatives: *Catapsydrax dissimilis* (Cushman & Bermudez), *Globigerina venezuelana* Hedberg, *Globigerina sp.*, *Globigerina officinalis* Subbotina, *Globigerinatheka tropicalis* (Blow & Banner), *Turborotalia pomeroli* (Toumarkine & Bolli), *Globigerina triloculinoides* Plummer, *Globigerina bulloides* d'Orbigny, *Globigerina eocaenica* Terquem.

Most common representatives of the benthic foraminifers is from the genus *Cibicides* with the species: *Cibicides cf. dutemplei* (d'Orbigny), *Cib-*

icides ungerianus d'Orbigny and than as second most common is coming the genus *Robulus* with the species: *Robulus orbicularis* (d'Orbigny), *Robulus limbatus* (Bornemann), *Robulus cf. inornatus* (d'Orbigny), *Robulus cultratus* (Montfort), *Robulus cf. pseudovortex* Cole. Several samples from the genera are found also: *Vaginulinopsis*, *Karrerella*, *Bathysiphon*, *Glandulina*, *Cyclammina sp.*, *Textularia*, *Clavulinoides szaboi*, *Gyroidina*, *Nonion*, *Marginulina*, *Chrysalogonium*, *Uvigerina*, *Bulimina*, *Eponides*. Porcelaneous foraminifera is represented with representatives of the species: *Trilocu-*

lina, *Quinqueloculina* and *Pyrgo* which were found in several samples, and are usually tiny, with more dimensions and badly conserved. The discovered fauna material derives from aleurolite- marly-sandy sediments.

If analyses are made to the macro-paleontologic section in whole, most interesting is the upper part of the section of the drilling, deepness interval from 1670 – 10 (samples 13–19) where by percentage of involvement the planktonic foraminifers are dominating.

The middle and bottom part of the sediment series is practically sterile from viewpoint of the microfossils content, with exception of some samples which have from one to two microfossils and does not have stratigraphic value.

The association of the planktonic foraminifers and vertical distribution of separate taxa, contained in the KR-1: *Catapsydrax dissimilis* (Cushman & Bermudez), *Globigerina venezuelana* Hedberg, *Globigerina* sp., *Globigerina officinalis* Subbotina, *Globigerinatheka tropicalis* (Blow & Banner), *Turborotalia pomeroli* (Toumarcine & Bolli), *Globigerina triloculinoides* Plummer, *Globigerina bulloides* d'Orbigny, *Globigerina eocaenica* Ter-

quem, gave us the chance to identify one local biostratigraphic zone *Catapsydrax dissimilis* – *Globigerinatheka tropicalis* in the Tikveš basin. The highest parts (samples 13 – 19) of the profile KR – 1 belong to the local biostratigraphic zone *Catapsydrax dissimilis* – *Globigerinatheka tropicalis*, and the sediments of the upper flysch lithozone are belonging to the Upper Eocene – Priabonian geological age.

The biostratigraphic zone *Catapsydrax dissimilis* – *Globigerinatheka tropicalis* is characterized with the species concurrent zone – zone of vertical distribution of at the same time for first time occurrence of the species *Catapsydrax dissimilis* (Cushman & Bermudez), till the last disappearance of the species *Globigerinatheka tropicalis* (Blow & Banner). The bottom border of the zone is defined with the first occurrence of the index species *Catapsydrax dissimilis* (Cushman & Bermudez), and the upper border is positioned to the last disappearance of the index species *Globigerinatheka tropicalis* (Blow & Banner). The borders of the zone represent the interval on the middle P 15 to the end of P 17 and are belonging to the Upper Eocene – Priabonian geological age (Fig. 4).

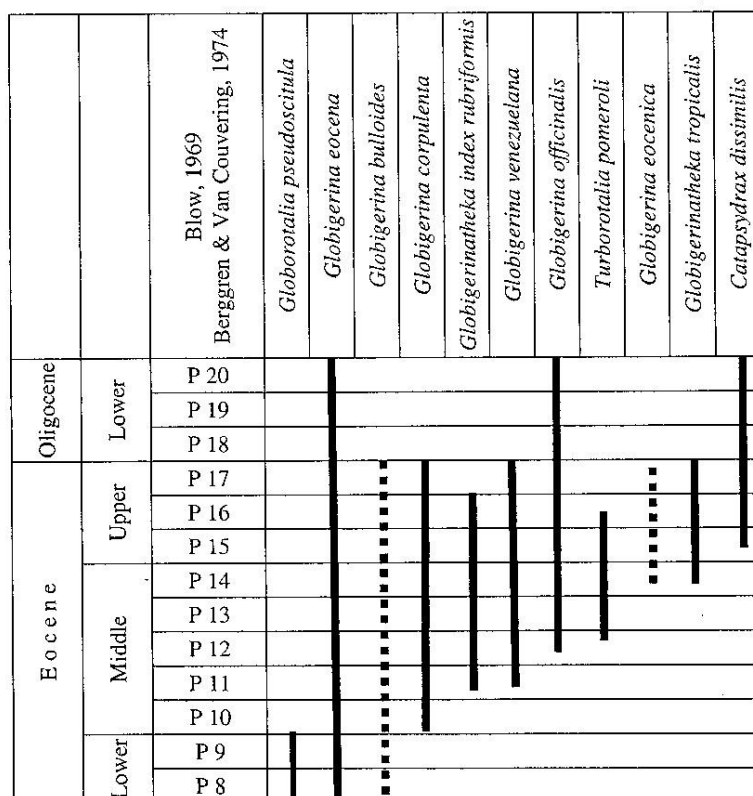


Fig. 4. Stratigraphic distribution of selected planktonic foraminifers from the Paleogene (Toumarkine & Bolli, 1985)

The main characteristic of the zone is the presence of other benthic foraminifer species in the profile:

- species which are found only in the zone *Catapsydrax dissimilis* (Cushman and Bermudez) and *Globigerinatheka tropicalis* (Blow & Banner).

- species which come from the older levels and disappear in within zone: *Globigerina venezuelana* (Hedberg), *Globorotalia pseudoscutula* (Glaesner), *Globigerina inflata* (d'Orbigny), *Globorotalia triloculinoides* (Plummer), *Robulus arcuatostratus* (Hantken), *Robulus pseudovortex* Cole, *Robulus inornatus* (d'Orbigny), *Globigerina bulloides* (d'Orbigny);

- species that are found in the zone, but continue later *Spiroplectammina nuttalli* Lal, *Karriella brady* (Cushman);

- species which are transitional for the zone: *Globigerina eocaena* Gümbel, *Globigerina officinalis* (Subbotina), *Globigerina eocaenica* Terquem, *Quinqueloculina juleana* d'Orbigny, *Guttulina problema* d'Orbigny, *Giroidina soldani* (d'Orbigny), *Giroidina girardana* (Reuss), *Eponides umbonatus* (Reuss), *Eponides pygmeus* (Hantken), *Pullenia quadriloba* (d'Orbigny), *Pullenia bulloides* (d'Orbigny), *Anomalina grosserugosa* (Gümbel), *Planulina costata* (Hantken), *Cibicides ungerianus* d'Orbigny, *Cibicidoides mexicanus* Nuttall, *Cibicides dutemplei* (d'Orbigny), *Elphidium advenum* (Cushman).

The highest levels of the section OP-1, the interval between the samples 35 – 39 belong to the local biostratigraphic zone *Catapsydrax dissimilis* (Cushman and Bermudez) – *Globigerinatheka tropicalis* (Blow & Banner), are characterized by Upper Eocene – Priabonian geological age.

The sediments of the upper flysch lithozone on depth of 1670–10 m (samples from 13–19) from the section KR-1 of the Tikveš basin belong to the local biostratigraphic zone *Catapsydrax dissimilis* (Cushman and Bermudez) – *Globigerinatheka tropicalis* (Blow & Banner), to the Upper Eocene – Priabonian geological age.

Stratigraphic correlation between sections OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin)

For the stratigraphic correlation between the sections OP-1 and KR-1, is started from the mutually included elements connected for several Paleogene beds, i. e. from zones that have most of the paleontology data – foraminifers (Fig. 5).

In such a case, for correlation between drill-holes OP-1 and KR-1, as standard horizons were taken zones with planktonic foraminifers.

Considering drill-hole OP-1 as marker bed was determined the depth range 32 – 39 with most common presence of planktonic foraminifers: *Globorotalia pseudoscutula* (Glaes), *Globigerina bulloides* (d'Orbigny), *Globigerina corpulent* (Subbotina), *Globigerina eocaenica* Terquem, *Globigerina* sp., *Globigerina venezuelana* (Hedberg), *Globigerina triloculinoides* (Plummer), *Globigerina eocaena* (Gümbel), *Turborotalia pomeroli* (Toumarkine), *Globigerina officinalis* (Subbotina), *Catapsydrax dissimilis* (Cushman & Bermudez), *Globigerinatheka tropicalis* (Blow & Banner), *Globigerina triloculinoides* (Plummer) и *Globigerinatheka index rubriformis* (Subbotina). The bottom stratigraphic level of the profile is represented with association of planktonic foraminifers which are included in the sample 32. The upper stratigraphic level is represented with the association of the foraminifers in the sample 39.

Paleogene beds of the drill hole represents the depth interval between samples 13 and 19 in association of planktonic foraminifers.

And in the section KR-1, the bottom stratigraphic level is represented with the association of planktonic foraminifers in the sample 13, and the upper level is represented with the Foraminifera association in sample 19. From the correlation can be concluded that of the KR-1 drill-hole, between the samples 13 – 19, are on the same stratigraphical level with the layers from the drilling OP-1, in the depth interval between the samples 32 – 39 (directly under the surface). In this horizon are included the leading planktonic species *Catapsydrax dissimilis* (Cushman and Bermudez) and *Globigerinatheka tropicalis* (Blow & Banner), which have the shortest vertical distribution from the zone P15 to the zone P17. This elements gave us the chance to define the Upper Eocene, which directed us to its highest Upper part – horizon (P17), and the horizon which represents the base of pre-abon (P15), determines the border of the Upper Eocene in relation with the older Paleogene.

The joint of plankton foraminifer fauna in the Upper Eocene sediments of the section OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin) shows us the similar bionomic conditions and existence of relations between this basins during the sedimentation of the sediments.

This kind of similarities probably exist with the other paleofaunistic association in the Eocene in the Mediterranean area.

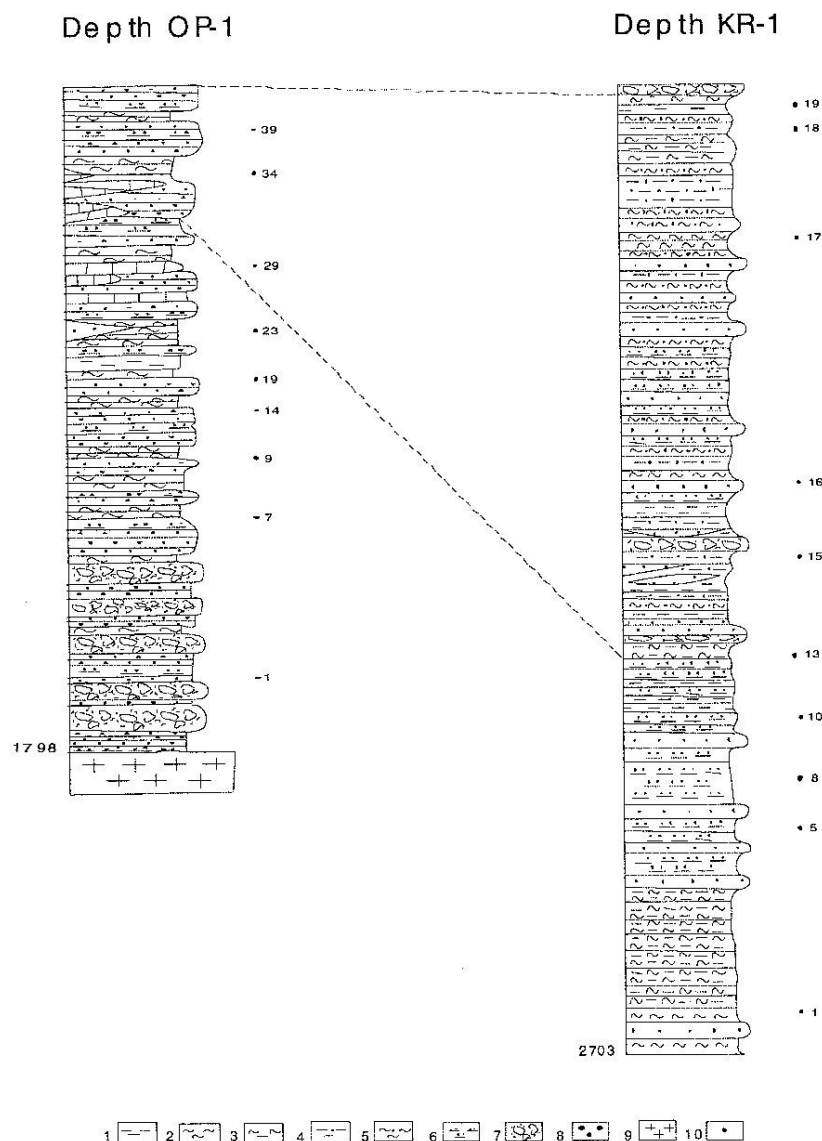


Fig. 5. Correlation of Paleogene beds in OP-1 and KP-1 well sections by planktonic Foraminifera
 1 – marly, 2 – clayey, 3 – marly-clayey sediments, 4 – marly sandstones, 5 – clayey sandstones, 6 – aleurolites,
 7 – conglomerates, 8 – sandstones, 9 – granites, 10 – samples

CONCLUSION

Based on the results of the stratigraphic distribution of the plankton of foraminifers species in the sections OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin), is identify *Catapsydrax dissimilis* (Cushman and Bermudez) – *Globigerinatheka tropicalis* (Blow & Banner) local biostratigraphic zone of the Upper Eocene – Priabonian geological age.

With this finding, the geological age of the Paleogene sediments from the upper flysch lithose of the Ovče Pole and Tikveš basins categorically belong to the Upper Eocene–Priabonian geological age.

In relation to this, correlation was made to the biostratigraphic zones between the Ovče Pole and Tikveš paleogenic basin. The joint of plankton foraminifer fauna in the Upper Eocene sediments of the sections OP-1 (Ovče Pole basin) and KR-1 (Tikveš basin) shows the similar bionomic conditions and existence of relations between this basins during the sedimentation of the sediments.

After the formation of this sediments the sedimentation stopped, most probably as a result of tectonic impulses, which in that time were very intense in the frames of the Alpic orogenic cycle.

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Резиме

КОРЕЛАЦИЈА НА СТРАТИГРАФСКА ФОРАМИНИФЕРНА РАСПРОСТРАНЕТОСТ ВО ОВЧЕПОЛСКИОТ И ТИКВЕШКИОТ ПАЛЕОГЕНСКИ БАСЕН ВО РЕПУБЛИКА МАКЕДОНИЈА

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Клучни зборови: палеоген; бентосни и планктонски фораминифери; биостратиграфска зона; овчеполски басен; тиквешки басен

Овчеполскиот и тиквешкиот палеогенски басен претставуваат големи седиментни маси и припаѓаат на источниот и централниот дел од вардарската зона на територијата на Македонија.

Според досегашните истражувања, староста на палеогените седименти (на база на многубројни фосилни остатоци од макрофосилните групи) во овчеполскиот и тиквешкиот басен е одредена како горноеоценовска.

Во трудот ги презентираме резултатите од микрорепалеонтолошките истражувања на планктонската

фораминиферна фауна, пронајдена во горната флиш-на литозона на дупчотините ОП-1 (овчеполски басен) и КР-1 (тиквешки басен). Биостратиграфската вредност на планктонската фораминиферна фауна во дупчотините ОП-1 и КР-1 овозможува да издвоиме една локална биостратиграфска зона во овчеполскиот и во тиквешкиот басен.

Во контекст со тоа, направена е корелација на биостратиграфските зони помеѓу овчеполскиот и тиквешкиот палеогенски басен.

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| Geologica Macedonica | Год. | стр. | Штип |
| Geologica Macedonica | Vol. 22 | 1-62 | 2008 |
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